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LOSS OF THE ECTODERM OF *HYDRA VIRIDIS* IN THE LIGHT OF A PROJECTION MICROSCOPE.

WILLIAM L. TOWER.

WHILE working with a projection microscope in December, 1897, I placed a living *Hydra viridis* in a small stage aquarium and projected its image upon a screen. The response of the hydra to this stimulus was startling.

My apparatus consisted of an alternating current arc-lamp of fifty-two volt, twelve ampere capacity. The light was taken by a pair of four-and-one-half-inch condensers, and was passed by them through an alum cell to remove the heat rays, then through a bi-convex condensing lens, an Abbé condenser, and finally through the object into the objective.

Projected in this manner, an unexpected sight was visible on the screen. The ectodermal cells, either singly or in groups, were seen to leave the animal, float free in the liquid, and gradually sink out of sight, leaving the hydra composed solely of endoderm, and the thin layer of mesodermal tissue. The cells were not distorted in any way, but retained their normal shape, acting as if they had been separated by some delicate and effective disassociation method. This result, and the fact that it could not be due to heat, as will appear later, led to the further investigation of the phenomenon.

The material had been collected in October, and kept in the laboratory, where it had multiplied to a considerable extent. The hydræ were removed one at a time with a pipette, and placed in the stage aquarium ordinarily used for such purposes, where they were left from twelve to eighteen hours, during which time they fully recovered from being handled. They were then carefully placed upon the stage of the projection microscope. By using sufficient care it was possible to bring the animal at once into the field in an unstimulated condition and fully expanded.

In each of the one hundred and twenty-four times a hydra was placed in the field of the microscope it immediately underwent violent contraction, followed by speedy recovery of the elongated form. In four cases a response of this kind was noted in five seconds from the time the hydra was placed in the light. In two cases a period of forty seconds elapsed before any response was noted.

This response was accompanied by the discharge of a number of the nettle cells on the tentacles. In the great majority of cases the loss of the ectodermal cells began about the time when the animal regained its elongated form. Usually all of the ectoderm was lost, but in a few individuals a small number of cells would adhere to the upper part of the animal. In one case the ectoderm was completely lost in one minute, while another required eleven minutes for its removal (see table, also Fig. 1).

TABLE OF RESPONSES OBTAINED.

Total number of individuals, 124.

First response:

Time in seconds,	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*
No. of individ.,	4	71	6	2	1	10	28	2

Lost ectoderm:

Time in minutes,	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
No. of individ.,	1	0	6	10	80	7	1	2	3	13	1

Ectoderm regenerated:

Time in days,	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*
No. of individ.,	1	0	4	7	7	10	20	30	20	12	3	1	0	0
	23	*24*	*25*	*26*	*27*	*28*	*29*	*30*	*31*	*32*	*33*			
	1	2	1	0	0	0	1	2	0	1	1			

Time lived after second trial:

Time in days,	*3*	*4*	*5*	*6*	*7*	*8*	*9*
No. of individ.,	2	2	10	42	44	14	10

The first response is evidently due to the concentration of light upon the animal. An interesting point about the response to the light stimulus is the grouping of the individuals about two modes (Fig. 2). One set responds quickly, and tends to gather about a mode of ten (seconds). The other set requires a continued application of the stimulus for a longer time before the response takes place. These latter tend to group themselves about a mode of thirty-five (seconds). Between these two almost no cases were found.

I cannot explain the loss of the ectoderm. It could not be due to heat, for the alum cell effectually cut out that element, as was shown by placing the bulb of a delicate thermometer in the aquarium containing the hydra. There was no change whatever, and the water remained constantly at the temperature of the room, which ranged from 15° to 18° C. It could not have been due to escaped currents of electricity, for insulation was perfect. Neither could it have been the effect of the Roentgen rays, although such are found in the arc-light. The distance of the object from the arc was forty-two inches, and the small amount of those rays generated by the arc-lamp could not have had, it seems, any effect at so great a distance, inasmuch as they were not focused or controlled by optical appliances. This dropping off of the hypodermis, however, resembles in many ways the blistering effects produced upon the skin by Roentgen rays.

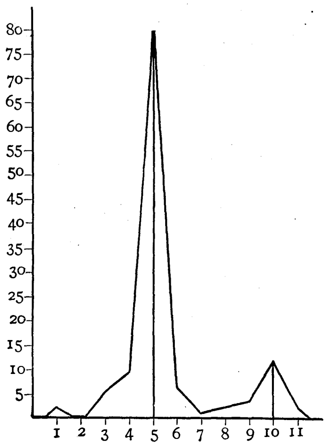

Fig. 1.

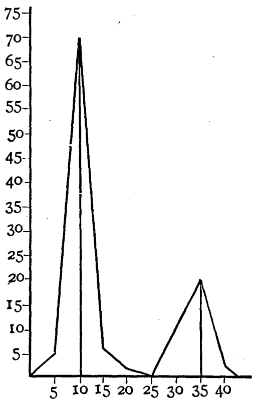

Fig. 2.

Fig. 1. — Curve of the first response. The ordinates represent time (in seconds), and abscissas represent individuals. It is to be noted that the individuals fall in two classes with one mode at ten and the other at thirty-five seconds.

Fig. 2. — Loss of ectoderm. Curve showing the arrangement of the individuals about two modes; one at five, the other at ten (minutes). Ordinates = time in minutes. Abscissas = number of individuals.

No experiments were made to determine what light rays were responsible for this, excepting that it was noted in making a photo-micrograph, using light of long wave-length, that the phenomenon did not occur; but if rays of short wave-length were used, it was impossible to obtain a sharp photograph, owing to the sloughing of the hypodermis. Microscopical examination showed that the sloughing had occurred, and it was also seen on the focusing screen of the camera. Beyond this I did not determine the action of the rays of different wave-lengths, although I believe this phenomenon is in some way related to rays of short wave-length.

After the removal of the ectoderm by this means, the hydra was very unresponsive to stimuli. It remained in an elongated condition even when handled violently. Before twenty-four hours had elapsed it had contracted into an oval mass, with the tentacles almost entirely retracted; but it recovered its normal expanded condition in three or four days.

It is interesting in connection with this to note the regeneration of the ectoderm. Each hydra, after having been subjected to this treatment, was placed in a small bottle and given plenty of fresh water until it recovered. The most rapid recovery took place in nine days, while the slowest required thirty-three. The great majority recovered in from fifteen to seventeen days (see table). I have made no histological study of the regeneration of the ectoderm, but observed it with considerable constancy in the living animals, and found that it appeared first about the oral end.

If a hydra after complete recovery, that is, after complete regeneration of the ectoderm, was again subjected to the same treatment, the second response to light would occur in about the same time as before, and usually fall in the same modal class. This was true also for the loss of the ectoderm. It was noted, however, that some of the individuals that responded quickly to light and to the stimulus that removed the ectoderm in the first trial showed a near approach, or completely conformed to the second modal class in the second trial.

I was not able to obtain a second regeneration. The hydra did not recover at all, but remained as if stupefied, moving only when chemically stimulated. In three or four days it would be found contracted, and in six or seven days would macerate and entirely disappear.

The case is interesting, and, as far as I know, no similar one has ever been recorded. It is manifestly a case of response to some form of radiant energy, either of light or short wave-length, or of some other form beyond the visible end of the spectrum. It would have been desirable to have carried out histological studies upon this material, but I was unable to do so at the time.

CAMBRIDGE, MASS., Feb. 10, 1899.